

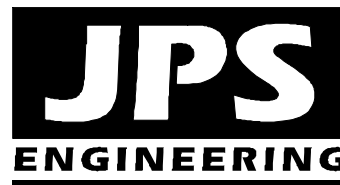
**FINAL DRAINAGE REPORT**  
**for**  
**KETTLE CREEK ESTATES FILING NO. 2**

**Prepared for:**

**J + M Investments LLC**  
5655 Bridlespur Ridge Place  
Colorado Springs, CO 80918

November 30, 2023  
Revised August 16, 2024

**Prepared by:**



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**JPS Project No. 112303**  
**PCD File No.: VR246**

**KETTLE CREEK ESTATES FILING NO. 2**  
**FINAL DRAINAGE REPORT**  
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DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

Please provided  
engineer stamp and  
signature

---

John P. Schwab, P.E. #29891

Developer's Statement:

I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Provide owner  
signature and date

By:

---

Printed Name: Jay Stoner  
J+M Investment, LLC  
5655 Bridlespur Ridge Place, Colorado Springs, CO 80918

Date

El Paso County's Statement

Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volumes 1 and 2, and Engineering Criteria Manual as amended.

---

Joshua Palmer, P.E.  
County Engineer / ECM Administrator

Date

Conditions:

## **I. GENERAL LOCATION AND DESCRIPTION**

### **A. Background**

Kettle Creek Estates Filing No. 2 is a proposed 2-lot rural residential minor subdivision located in northern El Paso County, Colorado. The property is an existing 5.13-acre lot (El Paso County Assessor's Number 62280-05-033) located at the southeast corner of Old Ranch Road and Otero Avenue (currently addressed as 10245 Otero Avenue). The proposed minor subdivision (replat) will create two residential lots with a minimum lot size of 2.5-acres. There are no public improvements required for the proposed minor subdivision, and the site disturbance associated with subdivision improvements will be limited to less than one acre.

### **B. Scope**

This report will provide a summary of site drainage issues impacting the proposed residential minor subdivision. The report will analyze upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual, and the report is intended to fulfill the requirements for a "Final Drainage Report" in support of the Final Plat process for this property.

### **C. Site Location and Description**

Kettle Creek Estates Filing No. 2 is a replat of Lot 1, Kettle Creek Estates, located in Section 28, Township 12 South, Range 66 West of the 6th Principal Meridian. Kettle Creek Estates was recorded as an administrative lot line adjustment, consisting of a replat of Lots 7 and 8, Spring Crest Amended Filing.

The 5.13-acre parcel is currently a vacant, platted residential lot described. The north side of the property will be platted as the 2.63-acre Lot 1, and the south side of the property will be platted as the 2.5-acre Lot 2. The property was re-zoned in 2022 from RR-5 (rural residential; 5-acre minimum lot size) to RR-2.5 (rural residential; 2.5-acre minimum lot size) under County Project File #: P-22-004, and the proposed minor subdivision is fully in conformance with the current zoning of the site. Both of the proposed lots will be accessed by driveway connections to Otero Avenue, which is an asphalt-paved public street along the west boundary of the subdivision.

The site is bordered by a combination of developed and vacant rural residential properties on all sides. (Zoned RR2). The west boundary of the property adjoins Otero Avenue, and Lots 4 and 5, Hunsinger Subdivision are located along the west side of Otero Avenue. The north boundary of the property adjoins Old Ranch Road. The east boundary of the property adjoins Lot 2, Kettle Creek Estates, and the south boundary of the property adjoins Lot F, Spring Crest Filing No. 2.

The site is located in the Kettle Creek Drainage Basin, and the existing on-site drainage swales flow into the Kettle Creek drainage channel, which flows southwesterly along the east side of the property. The terrain is rolling with average grades ranging from 5 to 20 percent. Ground elevations within the site range from approximately 6,640 to 6,700 feet above mean sea level. The site is vegetated with meadow grasses and trees.

#### **D. General Soil Conditions**

According to the Custom Soil Resource Report for this site (see details in Appendix A) provided by the Natural Resources Conservation Service (NRCS), on-site soils are comprised of “Type 85: Stapleton-Bernal sandy loam.” These soils are classified as hydrologic soils group “B” (moderate infiltration rate).

#### **E. References**

City of Colorado Springs & El Paso County “Drainage Criteria Manual (DCM),” revised October 31, 2018.

City of Colorado Springs “Drainage Criteria Manual, Volumes 1 and 2,” revised October 31, 2018.

El Paso County “Engineering Criteria Manual,” revised December 13, 2016.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0506G, December 7, 2018.

Terra Nova Engineering, Inc., “Final Drainage Report for Hunsinger Subdivision,” May, 2019 (approved by County 10/3/19).

## **II. DRAINAGE BASINS AND SUB-BASINS**

### **A. Major Basin Description**

The proposed development lies completely within the Kettle Creek Drainage Basin (FOMO3000) as classified by El Paso County. Stormwater runoff from the property drains into the main channel of Kettle Creek, which flows southwesterly along the east side of the property, ultimately flowing to a downstream confluence with Monument Creek.

### **B. Floodplain Impacts**

The project site is impacted by the 100-year floodplain along the Kettle Creek drainage channel as delineated by the Federal Emergency Management Agency (FEMA). The floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Panel Number 08041C0506G dated December 7, 2018 (see Firmette Exhibit in Appendix C). According to the FEMA Flood Insurance Study (FIS), the 100-year peak flows in the Kettle Creek drainage channel are identified as  $Q_{100} = 9,300$  cfs.

The subdivision plat identifies the entire 100-year floodplain area as a “no build area,” and there is no development proposed within the existing FEMA floodplain.

**C. Sub-Basin Description**

The existing drainage basins lying in and around the proposed development are depicted on Figure EX1 (Appendix C). The property has been delineated as three on-site drainage basins (Basins A1, A2, and B), flowing towards the Kettle Creek drainage channel.

Developed runoff in this minor subdivision will generally continue to follow historic paths.

**III. DRAINAGE DESIGN CRITERIA**

**A. Development Criteria Reference**

No Drainage Basin Planning Study (DBPS) has been completed for the Kettle Creek Drainage Basin. No Master Development Drainage Plan (MDDP) reports were found for any adjacent subdivisions, and no Final Drainage Reports (FDR) have been found in County records for Spring Crest Amended Filing or Kettle Creek Estates.

**B. Hydrologic Criteria**

The tributary drainage basins impacting this site are all less than 100 acres, so Rational Method Hydrology procedures were utilized for calculation of peak flows. Rational Method hydrologic calculations were based on the following assumptions:

- Design storm (minor) 5-year
  - Design storm (major) 100-year
  - Rainfall Intensities El Paso County I-D-F Curve
  - Hydrologic soil type B
- |                                      |           |             |
|--------------------------------------|-----------|-------------|
|                                      | <u>C5</u> | <u>C100</u> |
| • Runoff Coefficients - undeveloped: |           |             |
| Meadow / Forest areas                | 0.08      | 0.35        |
| • Runoff Coefficients - developed:   |           |             |
| Proposed Building / Pavement Areas   | 0.90      | 0.96        |
- (see composite runoff coefficient calculations in Appendix B)

Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage plan drawings.

#### IV. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

##### Step 1: Employ Runoff Reduction Practices

- **Minimize Impacts:** The proposed minor rural residential subdivision is an inherently low impact development. The proposed 2.5-acre minimum lot sizes will significantly minimize drainage impacts in comparison to higher density development alternatives.

##### Step 2: Stabilize Drainageways

- The major drainageway of Kettle Creek flows southwesterly along the east side of the property. As noted on the enclosed Developed Drainage Plan, property owners will preserve the existing vegetated buffer strip areas downstream of the designated drainage envelopes on the west side of the two lots.
- The existing floodplain along the Kettle Creek drainage channel will be protected and preserved as a greenway area through dedication of floodplain / drainage easements on the subdivision plat. No disturbance or improvements to the existing channel are proposed as part of this 2-lot subdivision replat. The dedicated drainage easements along the channel provide access for potential future channel improvements by the County, Colorado Springs Utilities, or other entities.
- **Drainage basin fees paid at the time of recording of the subdivision plat provide the applicable cost contribution towards regional drainage improvements, including potential future channel improvements.**

Explain what improvements are necessary if any from the developer for the channel at this time

##### Step 3: Provide Water Quality Capture Volume (WQCV)

- Water quality detention is not required based on the low density of the rural residential development proposed (minimum lot size of 2.5-acres). According to ECM Appendix I Section I.7.1.B.5, a single-family residential lot greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent is excluded from permanent WQ control measures. As detailed in Appendix B, the estimated impervious area for the subdivision has been calculated as 9.9 percent, which meets the criteria for exclusion from water quality requirements.

##### Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial or commercial land uses are proposed as part of this development.

## V. GENERAL DRAINAGE RECOMMENDATIONS

The developed drainage plan for the site is to provide and maintain positive drainage away from structures and conform to the established drainage patterns for the overall site. JPS Engineering recommends that positive drainage be established and maintained away from all structures within the site in conformance with applicable building codes and geotechnical engineering recommendations.

Individual lot grading is the sole responsibility of the individual builders and property owners. Final grading of each home site should establish proper protective slopes and positive drainage in accordance with applicable housing industry standards, HUD guidelines, and building codes. In general, main floor elevations for each home should be established a minimum of 2 feet above the adjoining street.

In general, we recommend a minimum of 6 inches clearance from the top of concrete foundation walls to adjacent finished site grades. Positive drainage slopes should be maintained away from all structures, with a minimum recommended slope of 5 percent for the first 10 feet away from buildings in landscaped areas, a minimum recommended slope of 2 percent for the first 10 feet away from buildings in paved areas, and a minimum slope of 1 percent for paved areas beyond buildings.

## VI. DRAINAGE FACILITY DESIGN

### A. General Drainage Concept

Development of the proposed minor subdivision will not require any public improvements, as access to the two lots will be provided by driveway connections to Otero Avenue along the west boundary of the subdivision. The general concept for management of developed storm runoff is to establish site grading to provide positive drainage away from the building pads and divert runoff to drainage swales following historic drainage patterns.

### B. Kettle Creek Channel

The existing major drainage channel of Kettle Creek flowing through the east side of the site will be protected and preserved through dedication of drainage / floodplain easements on the plat.

The existing channel flows southwesterly along the east side of the site with a longitudinal slope in the range of 1.9 percent, variable bottom width ranging from 6-20 feet, and variable side slopes. While a detailed channel stability analysis is beyond the scope of this minor replat drainage report, the Kettle Creek channel would be expected to experience erosive velocities during major storm events based on the 100-year peak flows identified in the FIS ( $Q_{100} = 9,300$  cfs). Vertical banks with depths in the range of 3-8 feet are evident along some segments of the existing channel.

Please provide analysis for the channel along the property boundary in several cross sections detail velocity, Froude, shear etc and provide pictures of the bank and channel to see the extent and severity of undercutting and what improvements may be needed now or as part of the site plans. The current channel stability must be addressed.



Discuss if the channel needs any improvements or if armoring is necessary.

The proposed subdivision plat for Kettle Creek Estates Filing No. 2 provides a substantial “no-build” area buffer through dedication of wide floodplain easements (ranging from 90’ wide to over 200’ wide) along the existing Kettle Creek channel running through the site, with the intention of protecting this existing greenway and drainage corridor. Based on the vegetated condition of the existing floodplain area, development and construction impacts to the existing natural channel will be minimized.

Property owners need to understand that Kettle Creek is an actively flowing stream subject to potential future erosion and meandering. The wide floodplain easements dedicated in this subdivision plat are intended to provide ample setback from the drainage channel to the designated building envelope areas for the two rural residential lots along Otero Avenue. Additional protection of the building envelope areas is provided by aligning the east edge of the proposed building envelopes with the 40-foot wide sewer easement following the existing Colorado Springs Utilities (CSU) public wastewater main. CSU has historically taken active measures to implement channel stability improvements in locations where pipeline infrastructure may be endangered by channel erosion.

According to the FEMA Flood Insurance Study (FIS), the Kettle Creek drainage basin comprises a total tributary area of 16.3 square miles. The area of this subdivision replat (5.1-acres) amounts to less than 0.05 percent of the total basin area. Development of the proposed 2-lot rural residential subdivision replat will have no significant impact on the downstream drainage channel.

### **C. Specific On-Site Drainage Planning Details**

#### **1. Existing Drainage Conditions**

Historic drainage conditions are depicted on Figure EX1 (Appendix C). The parcel is a historically vacant forest and meadow area. There are no existing drainage facilities within the property. There are no existing irrigation facilities, major utilities, or significant encumbrances impacting the site.

Basin A1 comprises the northwest part of the property, which drains southeasterly by sheet flow and vegetated drainage swales flowing into the Kettle Creek drainage channel along the east side of the property. Existing peak flows at Design Point #A1 are calculated as  $Q_5 = 0.7$  cfs and  $Q_{100} = 5.3$  cfs.

Basin A2 comprises a small area between the Kettle Creek drainage channel and the east boundary of the property. Basin A2 drains southwesterly by sheet flow and vegetated drainage swales flowing into the Kettle Creek drainage channel. Existing peak flows at Design Point #A2 are calculated as  $Q_5 = 0.2$  cfs and  $Q_{100} = 1.4$  cfs. Runoff from Basins A1 and A2 combines at Design Point #1, with existing peak flows calculated as  $Q_5 = 0.9$  cfs and  $Q_{100} = 6.6$  cfs.

Basin B comprises the south part of the property, which drains southeasterly by sheet flow and vegetated drainage swales flowing into the Kettle Creek drainage channel. Existing peak flows at Design Point #B are calculated as  $Q_5 = 0.8$  cfs and  $Q_{100} = 5.8$  cfs.

Runoff from Basins A1, A2, and B combines at Design Point #2, with existing peak flows calculated as  $Q_5 = 1.6$  cfs and  $Q_{100} = 11.9$  cfs. Drainage from Design Point #2 flows into the main channel of Kettle Creek, which is an existing stable vegetated channel.

## **2. Developed Drainage Conditions**

The developed drainage basins and projected flows are shown on the Developed Drainage Plan (Figure D1, Appendix C).

Basin A1 will be developed with a rural residential home site on the proposed Lot 1. Developed flows from Basin A1 will continue to drain southeasterly by sheet flow and vegetated drainage swales flowing into the Kettle Creek drainage channel. Developed peak flows at Design Point #1 are calculated as  $Q_5 = 1.7$  cfs and  $Q_{100} = 6.7$  cfs.

The majority of Basin A2 is located within the no-build area delineated as the 100-year floodplain along Kettle Creek, and no development is planned within Basin A2. Developed peak flows at Design Point #A2 are calculated as  $Q_5 = 0.2$  cfs and  $Q_{100} = 1.4$  cfs (matching existing conditions).

Runoff from Basins A1 and A2 combines at Design Point #1, with developed peak flows calculated as  $Q_5 = 1.9$  cfs and  $Q_{100} = 8.0$  cfs (100-year flow increase of 1.4 cfs compared to existing conditions).

Basin B will be developed with a rural residential home site on the proposed Lot 2. Developed flows from Basin B will continue to drain southeasterly by sheet flow and vegetated drainage swales flowing into the Kettle Creek drainage channel. Developed peak flows at Design Point #B are calculated as  $Q_5 = 1.7$  cfs and  $Q_{100} = 7.1$  cfs.

Runoff from Basins A1, A2 and B combines at Design Point #2, with developed peak flows calculated as  $Q_5 = 3.4$  cfs and  $Q_{100} = 14.4$  cfs (100-year flow increase of 2.5 cfs compared to existing conditions).

According to the FEMA Flood Insurance Study (FIS), the 100-year peak flows in the Kettle Creek drainage channel are identified as  $Q_{100} = 9,300$  cfs. As such, the drainage contribution from this minor rural residential subdivision area amounts to less than 0.2 percent of the total flow in the channel.

Recognizing the rural residential nature of the proposed subdivision (2.5-acre minimum lot sizes), the minor increase in developed flows will have no significant drainage impact on the Kettle Creek drainage channel. Future construction of the rural residential homes on the two

lots should implement appropriate erosion control measures and maximize preservation of vegetated buffer strips along the downstream sides of the property.

#### **D. On-Site Drainage Facility Design**

Developed drainage basins and drainage patterns are depicted on the enclosed Developed Drainage Plan (Sheet D1). No public drainage improvements are required for this minor subdivision. Based on the rural residential nature of this minor subdivision and the large (2.5-acre minimum) lot sizes proposed, there will be no significant increase in developed flows, and there is no need for on-site flood control detention.

#### **E. Analysis of Existing Downstream Facilities**

The proposed subdivision area will continue to drain southeasterly into the Kettle Creek drainage channel. Development of this property as a 2-lot rural residential subdivision replat will have no significant impact on downstream drainage facilities.

#### **F. Anticipated Drainage Problems and Solutions**

The drainage plan for this minor subdivision replat consists of maintaining positive drainage away from home sites and conveying surface drainage through the site in general conformance with historic drainage patterns. The primary drainage problems anticipated within this type of development consist of maintenance of proper drainage patterns and erosion control.

Care will need to be taken to implement proper erosion and sediment control measures associated with the proposed driveways, home sites, and drainage swales. Existing vegetated buffer strips should be protected and maintained along the downstream limits of the proposed building envelopes. Drainage facilities outside the public right-of-way will be owned and maintained by the individual lot owners unless otherwise noted.

### **VII. EROSION CONTROL / SEDIMENT CONTROL**

Contractors and Owners will need to implement and maintain proper Construction Control Measures (CCM's) for erosion and sediment control during and after construction. Erosion control measures should include installation of silt fence at the toe of disturbed areas, sediment control logs protecting drainage ditches, vehicle tracking control pads at access points, riprap protection at culvert outlets, and revegetation of disturbed areas. Cut slopes will need to be stabilized during excavation as necessary and vegetation will need to be re-established as soon as possible for stabilization of graded areas.

## VIII. STORMWATER DETENTION AND WATER QUALITY

As previously stated, the proposed development will result in a minimal increase in developed flows based on the rural residential development plan. There is no need for on-site stormwater detention based on the minimal developed drainage impact.

Water quality facilities are not required as this site meets exclusions listed in the revised El Paso County Engineering Criteria Manual (ECM). Section I.7.1.B.5 of the ECM identifies “Large Lot Single Family Sites” as excluded sites under the following definition: “A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent.” The proposed subdivision replat will create two rural residential lots with a minimum lot size of 2.5 acres. As detailed in Appendix B, the calculated impervious area for the proposed subdivision is 9.9 percent, which is below the “10 percent” threshold.

An El Paso County Erosion and Stormwater Quality Control Permit (ESQCP) will be required with development of each of the two individual lots in this subdivision (or alternatively a single ESQCP can be processed for both lots) because these lots are considered Sensitive Area sites per ECM Appendix I.4.2 (note that Table I-2 contains an error stating that a “BESQCP” is required for sites in a Sensitive Area when the table should state “ESQCP”). These lots are considered Sensitive Area sites due to: floodplain, wetlands, and endangered species habitat (Preble’s Meadow Jumping Mouse).

## IX. COST ESTIMATE AND DRAINAGE FEES

The developer will be responsible for all construction costs associated with the proposed subdivision infrastructure improvements. There are no reimbursable public drainage improvements required for this subdivision replat.

The property is located entirely within the Kettle Creek Drainage Basin (FOM 03000), which has a 2024 drainage basin fee of \$13,410 per impervious acre and no bridge fee. Applicable drainage basin fees are calculated as follows:

Subdivision Replat Area =	5.13 acres
Percent Impervious Area =	10.0%
Calculated Impervious area =	0.513 ac.
Adjusted Impervious area = (0.513 ac) * 75% =	0.385 ac.
(includes 25% reduction on drainage fees for 2.5 to 5-acre lots per ECM Appendix L Section 3.10.2a)	
Drainage Basin Fee = (0.385 ac.) @ \$13,410/ac. =	<u>\$5,162.85</u>

## **X. SUMMARY**

Kettle Creek Estates Filing No. 2 is a proposed rural residential minor subdivision consisting of two lots on a 5.13-acre site. Development of the proposed minor subdivision is anticipated to result in a minimal increase in developed runoff from the site, and erosion control best management practices will be implemented to mitigate developed drainage impacts. The proposed drainage patterns will remain consistent with historic conditions. Implementation and maintenance of proper erosion control measures will ensure that this minor subdivision has no significant adverse drainage impact on downstream properties or drainage facilities.

**APPENDIX A**  
**SOILS INFORMATION**



United States  
Department of  
Agriculture

**NRCS**

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for El Paso County Area, Colorado



# Preface

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Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require



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# How Soil Surveys Are Made

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Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

## Custom Soil Resource Report

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

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The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

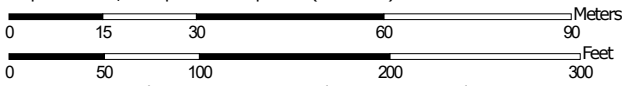
# Custom Soil Resource Report Soil Map



Soil Map may not be valid at this scale.




Map Scale: 1:1,210 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

### MAP LEGEND


**Area of Interest (AOI)**

 Area of Interest (AOI)

**Soils**







 Soil Map Unit Polygons

 Soil Map Unit Lines


 Soil Map Unit Points

**Special Point Features**






-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot

-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features

**Water Features**

 Streams and Canals

**Transportation**

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

**Background**

 Aerial Photography

### MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL:  
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado  
 Survey Area Data: Version 21, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.



## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	0.0	0.6%
85	Stapleton-Bernal sandy loams, 3 to 20 percent slopes	4.6	99.4%
<b>Totals for Area of Interest</b>		<b>4.6</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

## Custom Soil Resource Report

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## El Paso County Area, Colorado

### 19—Columbine gravelly sandy loam, 0 to 3 percent slopes

#### Map Unit Setting

*National map unit symbol:* 367p  
*Elevation:* 6,500 to 7,300 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 46 to 50 degrees F  
*Frost-free period:* 125 to 145 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Columbine and similar soils:* 97 percent  
*Minor components:* 3 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Columbine

##### Setting

*Landform:* Flood plains, fan terraces, fans  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium

##### Typical profile

*A - 0 to 14 inches:* gravelly sandy loam  
*C - 14 to 60 inches:* very gravelly loamy sand

##### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Very low  
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Very low (about 2.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* A  
*Ecological site:* R049XY214CO - Gravelly Foothill  
*Hydric soil rating:* No

#### Minor Components

##### Fluvaquentic haplaquolls

*Percent of map unit:* 1 percent  
*Landform:* Swales  
*Hydric soil rating:* Yes

**Other soils**

*Percent of map unit:* 1 percent  
*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:* 1 percent  
*Landform:* Depressions  
*Hydric soil rating:* Yes

**85—Stapleton-Bernal sandy loams, 3 to 20 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 36b1  
*Elevation:* 6,500 to 6,800 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 46 to 48 degrees F  
*Frost-free period:* 125 to 145 days  
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Stapleton and similar soils:* 55 percent  
*Bernal and similar soils:* 44 percent  
*Minor components:* 1 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Stapleton**

**Setting**

*Landform:* Hills  
*Landform position (three-dimensional):* Crest, side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Sandy alluvium derived from arkose

**Typical profile**

*A - 0 to 11 inches:* sandy loam  
*Bw - 11 to 17 inches:* gravelly sandy loam  
*C - 17 to 60 inches:* gravelly loamy sand

**Properties and qualities**

*Slope:* 3 to 15 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Low (about 4.7 inches)

## Custom Soil Resource Report

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 4e

*Hydrologic Soil Group:* B

*Ecological site:* R049XY214CO - Gravelly Foothill

*Hydric soil rating:* No

### Description of Bernal

#### Setting

*Landform:* Hills

*Landform position (three-dimensional):* Crest, side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Residuum weathered from sandstone

#### Typical profile

*A - 0 to 4 inches:* sandy loam

*Bt - 4 to 11 inches:* sandy clay loam

*C - 11 to 13 inches:* sandy loam

*R - 13 to 17 inches:* unweathered bedrock

#### Properties and qualities

*Slope:* 3 to 20 percent

*Depth to restrictive feature:* 8 to 20 inches to lithic bedrock

*Drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water supply, 0 to 60 inches:* Very low (about 1.8 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* D

*Ecological site:* R049XB204CO - Shallow Foothill

*Hydric soil rating:* No

### Minor Components

#### Other soils

*Percent of map unit:* 1 percent

*Hydric soil rating:* No

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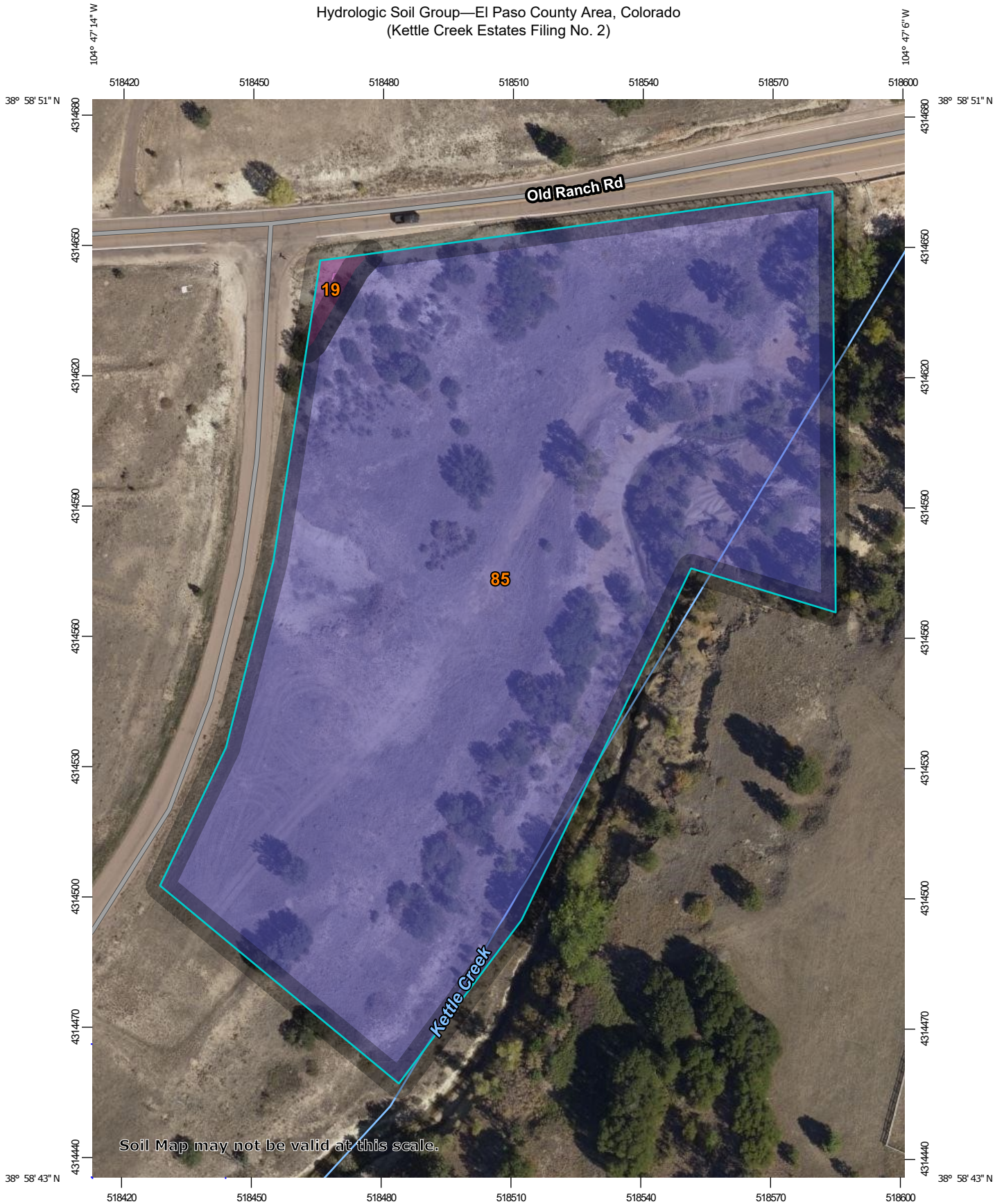
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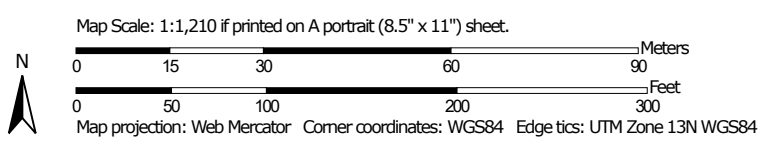
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Hydrologic Soil Group—El Paso County Area, Colorado  
(Kettle Creek Estates Filing No. 2)




Soil Map may not be valid at this scale.





## MAP LEGEND

### Area of Interest (AOI)









 Area of Interest (AOI)

### Soils

#### Soil Rating Polygons

 A  
 A/D  
 B  
 B/D  
 C  
 C/D  
 D  
 Not rated or not available

#### Soil Rating Lines

 A  
 A/D  
 B  
 B/D  
 C  
 C/D  
 D  
 Not rated or not available

#### Soil Rating Points

 A  
 A/D  
 B  
 B/D

 C  
 C/D  
 D  
 Not rated or not available


### Water Features

 Streams and Canals

### Transportation

 Rails  
 Interstate Highways  
 US Routes  
 Major Roads  
 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL:  
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado  
 Survey Area Data: Version 21, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	0.0	0.6%
85	Stapleton-Bernal sandy loams, 3 to 20 percent slopes	B	4.6	99.4%
<b>Totals for Area of Interest</b>			<b>4.6</b>	<b>100.0%</b>

### Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

**APPENDIX B**  
**HYDROLOGIC CALCULATIONS**

**Table 6-6. Runoff Coefficients for Rational Method**  
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

### 3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration ( $t_c$ ) consists of an initial time or overland flow time ( $t_i$ ) plus the travel time ( $t_t$ ) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time ( $t_i$ ) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion ( $t_t$ ) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad (\text{Eq. 6-7})$$

Where:

$t_c$  = time of concentration (min)

$t_i$  = overland (initial) flow time (min)

$t_t$  = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

### 3.2.1 Overland (Initial) Flow Time

The overland flow time,  $t_i$ , may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad (\text{Eq. 6-8})$$

Where:

$t_i$  = overland (initial) flow time (min)

$C_5$  = runoff coefficient for 5-year frequency (see Table 6-6)

$L$  = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)

$S$  = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

### 3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time,  $t_t$ , which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time,  $t_t$ , can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad (\text{Eq. 6-9})$$

Where:

$V$  = velocity (ft/s)

$C_v$  = conveyance coefficient (from Table 6-7)

$S_w$  = watercourse slope (ft/ft)

**Table 6-7. Conveyance Coefficient,  $C_v$** 

Type of Land Surface	$C_v$
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

\* For buried riprap, select  $C_v$  value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration ( $t_c$ ) is then the sum of the overland flow time ( $t_i$ ) and the travel time ( $t_t$ ) per Equation 6-7.

### 3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \quad (\text{Eq. 6-10})$$

Where:

$t_c$  = maximum time of concentration at the first design point in an urban watershed (min)

$L$  = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

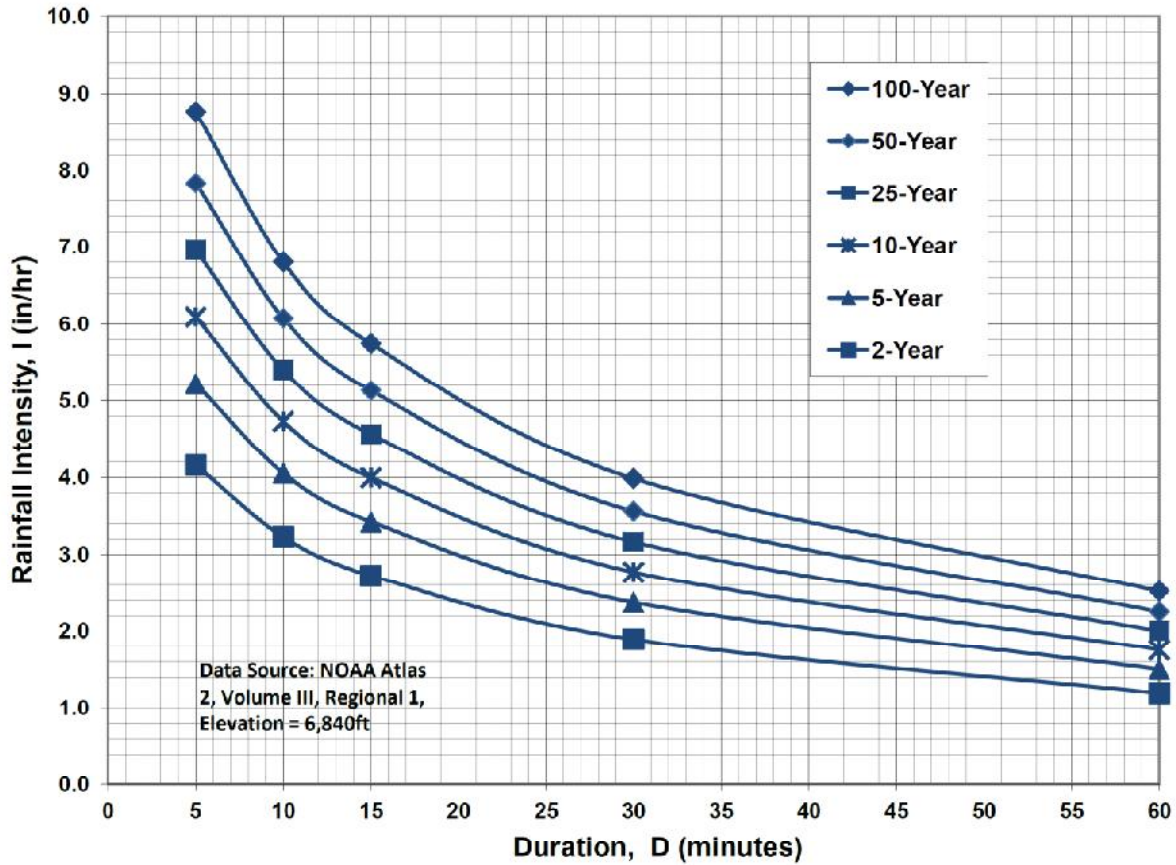
### 3.2.4 Minimum Time of Concentration

If the calculations result in a  $t_c$  of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum  $t_c$  for urbanized areas is 5 minutes.

### 3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

**Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency**



**IDF Equations**

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

Note: Values calculated by equations may not precisely duplicate values read from figure.



**KETTLE CREEK ESTATES FILING NO. 2  
IMPERVIOUS AREA CALCULATIONS**

<b>IMPERVIOUS AREAS - TYPICAL RURAL RESIDENTIAL LOTS - FOR REFERENCE ONLY</b>											
BASIN	TOTAL AREA (AC)	AREA PER LOT (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA PER LOT (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
<b>5-ACRE LOTS</b>	5.00	<b>0.35</b>	BUILDING / PAVEMENT	100.00	4.65	MEADOW/FOREST	0				7.000
<b>2.5-ACRE LOTS</b>	2.50	<b>0.275</b>	BUILDING / PAVEMENT	100.00	2.23	MEADOW/FOREST	0				11.000

\* PRESUMPTIVE IMPERVIOUS VALUE FOR 5-ACRE LOTS IS 7.0% PER EL PASO COUNTY DRAINAGE BASIN FEE ADDENDUM DATED 6/21/01

\* PRESUMPTIVE IMPERVIOUS VALUE FOR 2.5-ACRE LOTS IS 11.0% PER EL PASO COUNTY DRAINAGE BASIN FEE ADDENDUM DATED 6/21/01

<b>IMPERVIOUS AREAS - KETTLE CREEK ESTATES FILING NO. 2 (ASSUMING MAX. BLDG / PAVEMENT AREA OF 0.255-ACRES PER LOT)</b>											
BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
<b>RURAL RES. LOTS (2.5-AC w/o Streets)</b>	<b>5.13</b>	<b>0.51</b>	<b>BUILDING / PAVEMENT</b>	<b>100.00</b>	<b>4.62</b>	<b>MEADOW/FOREST</b>	<b>0</b>				<b>9.942</b>

**KETTLE CREEK ESTATES FILING NO. 2  
COMPOSITE RUNOFF COEFFICIENTS**

**DEVELOPED CONDITIONS**

**5-YEAR C-VALUES**

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A1	2.1	0.255	BUILDING / PAVEMENT	0.900	1.85	MEADOW/FOREST	0.08				0.180
A2	0.5	0.50	MEADOW/FOREST	0.080							0.080
A1,A2	2.6										0.160
B	2.5	0.255	BUILDING / PAVEMENT	0.900	2.25	MEADOW/FOREST	0.08				0.164
A1,A2,B	5.1										0.162

**100-YEAR C-VALUES**

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A1	2.1	0.255	BUILDING / PAVEMENT	0.960	1.85	MEADOW/FOREST	0.35				0.424
A2	0.5	0.50	MEADOW/FOREST	0.350							0.350
A1,A2	2.6										0.410
B	2.5	0.255	BUILDING / PAVEMENT	0.960	2.25	MEADOW/FOREST	0.35				0.412
A1,A2,B	5.1										0.411

**KETTLE CREEK ESTATES FILING NO. 2  
RATIONAL METHOD**

**EXISTING CONDITIONS FLOWS**

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN)	TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN)	INTENSITY <sup>(5)</sup>		PEAK FLOW	
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	T <sub>co</sub> <sup>(1)</sup> (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS <sup>(2)</sup> VELOCITY (FT/S)	T <sub>t</sub> <sup>(3)</sup> (MIN)			5-YR (IN/HR)	100-YR (IN/HR)	Q5 <sup>(6)</sup> (CFS)	Q100 <sup>(6)</sup> (CFS)
A1	A1	2.1	0.080	0.350	100	0.120	8.2	250	15	0.18	6.36	0.7	8.8	8.8	4.32	7.25	0.73	5.33
A2	A2	0.5	0.080	0.350	100	0.290	6.1	90	15	0.067	3.88	0.4	6.5	6.5	4.78	8.03	0.19	1.41
A1,A2	1	2.6	0.080	0.350									8.8	8.8	4.32	7.25	0.90	6.60
B	B	2.5	0.080	0.350	100	0.080	9.3	440	15	0.08	4.24	1.7	11.1	11.1	3.98	6.68	0.80	5.84
A1,A2,B	2	5.1	0.080	0.350									11.1	11.1	3.98	6.68	1.62	11.92

**DEVELOPED FLOWS**

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN)	TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN)	INTENSITY <sup>(5)</sup>		PEAK FLOW	
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	T <sub>co</sub> <sup>(1)</sup> (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS <sup>(2)</sup> VELOCITY (FT/S)	T <sub>t</sub> <sup>(3)</sup> (MIN)			5-YR (IN/HR)	100-YR (IN/HR)	Q5 <sup>(6)</sup> (CFS)	Q100 <sup>(6)</sup> (CFS)
A1	A1	2.1	0.180	0.424	100	0.120	7.4	250	15	0.18	6.36	0.7	8.0	8.0	4.46	7.49	1.69	6.67
A2	A2	0.5	0.080	0.350	100	0.290	6.1	90	15	0.067	3.88	0.4	6.5	6.5	4.78	8.03	0.19	1.41
A1,A2	1	2.6	0.160	0.410									8.0	8.0	4.46	7.49	1.86	7.98
B	B	2.5	0.164	0.412	100	0.080	8.6	440	15	0.08	4.24	1.7	10.3	10.3	4.08	6.86	1.67	7.06
A1,A2,B	2	5.1	0.162	0.411									10.3	10.3	4.08	6.86	3.37	14.37

1) OVERLAND FLOW T<sub>co</sub> = (0.395\*(1.1-RUNOFF COEFFICIENT))\*(OVERLAND FLOW LENGTH^(0.5))/(SLOPE^(0.333))

2) SCS VELOCITY = C \* ((SLOPE(FT/FT)^0.5)

C = 2.5 FOR HEAVY MEADOW

C = 5 FOR TILLAGE/FIELD

C = 7 FOR SHORT PASTURE AND LAWNS

C = 10 FOR NEARLY BARE GROUND

C = 15 FOR GRASSED WATERWAY

C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)

4) T<sub>c</sub> = T<sub>co</sub> + T<sub>t</sub>

\*\*\* IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL

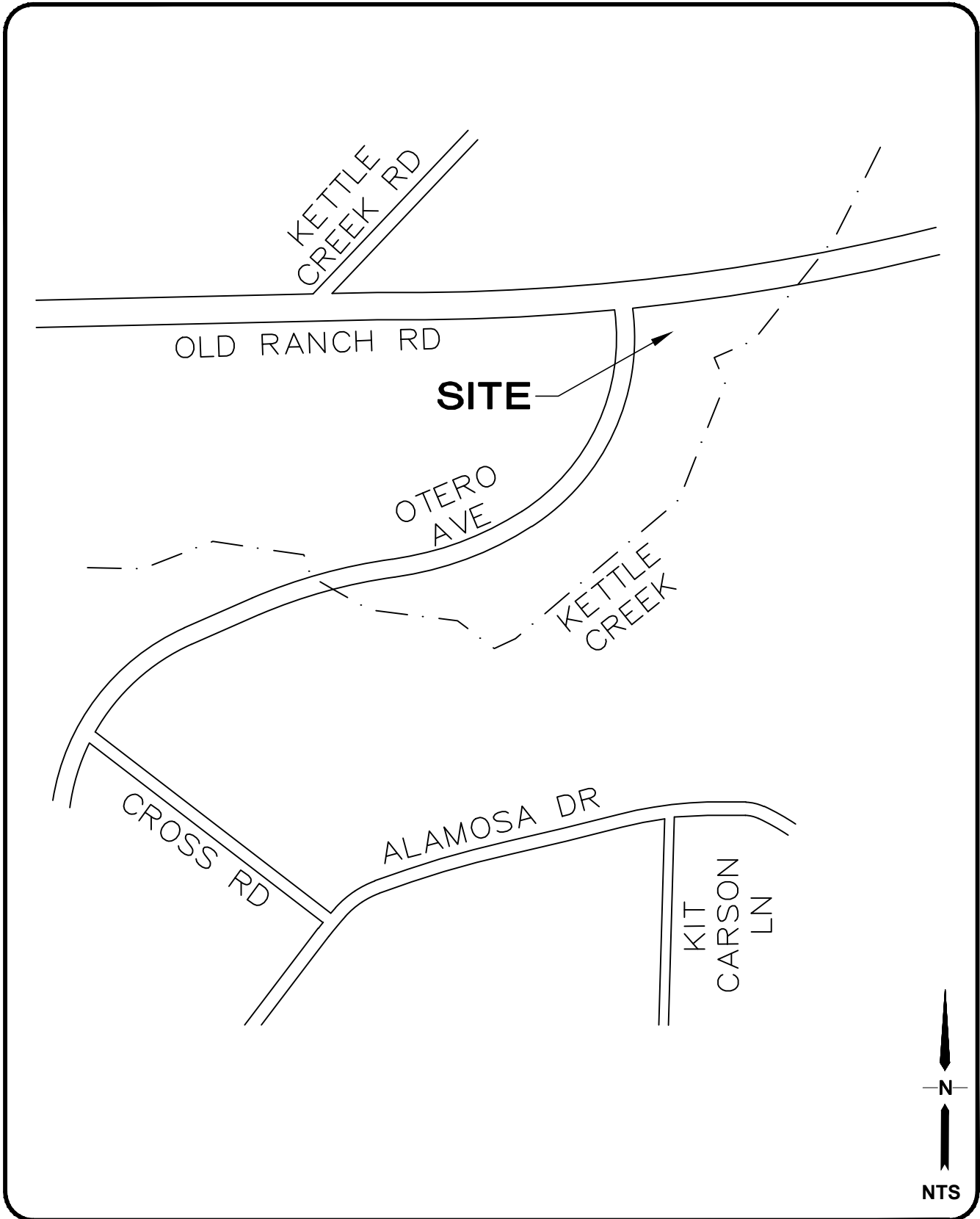
$$I_5 = -1.5 * \ln(T_c) + 7.583$$

$$I_{100} = -2.52 * \ln(T_c) + 12.735$$

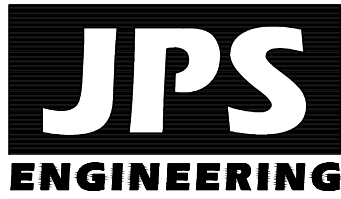
6) Q = C<sub>i</sub>A

## **APPENDIX C**

### **FIGURES**



VICINITY MAP



KETTLE CREEK ESTATE FILING NO. 2  
EL PASO COUNTY, CO

FIGURE A1

JPS PROJ NO. 112303

# National Flood Hazard Layer FIRMette



104°47'30"W 38°59'3"N



## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) Zone A, V, A99	With BFE or Depth Zone AE, AO, AH, VE, AR	Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X	Future Conditions 1% Annual Chance Flood Hazard Zone X	Area with Reduced Flood Risk due to Levee. See Notes. Zone X	Area with Flood Risk due to Levee Zone D

OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard Zone X	Effective LOMRs	Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer	Levee, Dike, or Floodwall

OTHER FEATURES	20.2 Cross Sections with 1% Annual Chance Water Surface Elevation	17.5 Coastal Transect	Base Flood Elevation Line (BFE)	Limit of Study	Jurisdiction Boundary	Coastal Transect Baseline	Profile Baseline	Hydrographic Feature

MAP PANELS	Digital Data Available	No Digital Data Available	Unmapped

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **11/28/2023 at 5:19 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

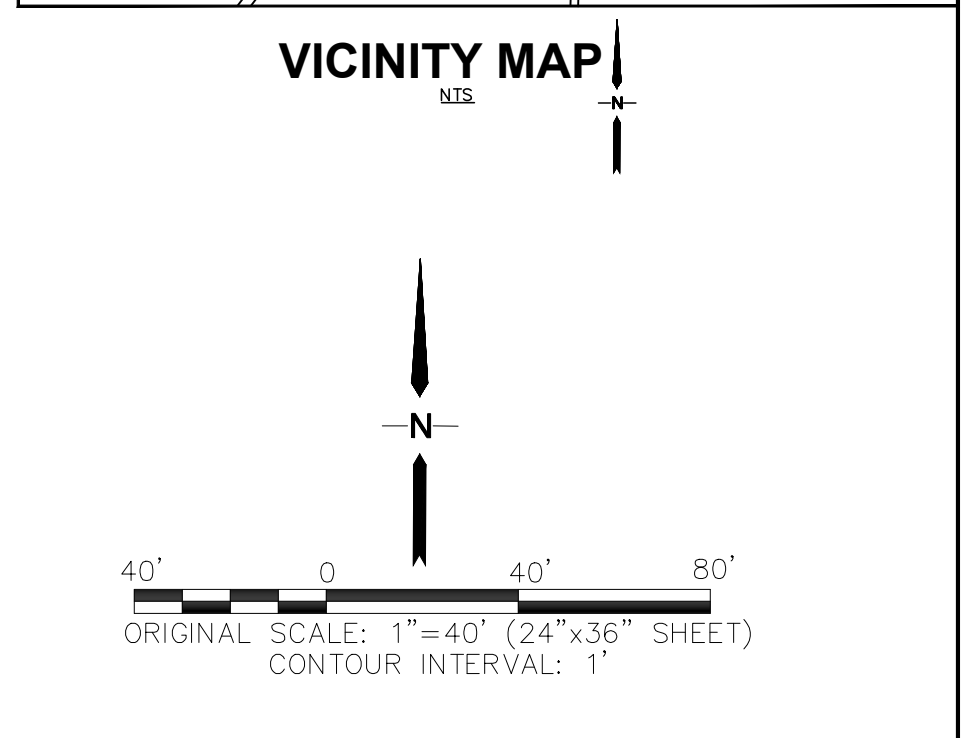
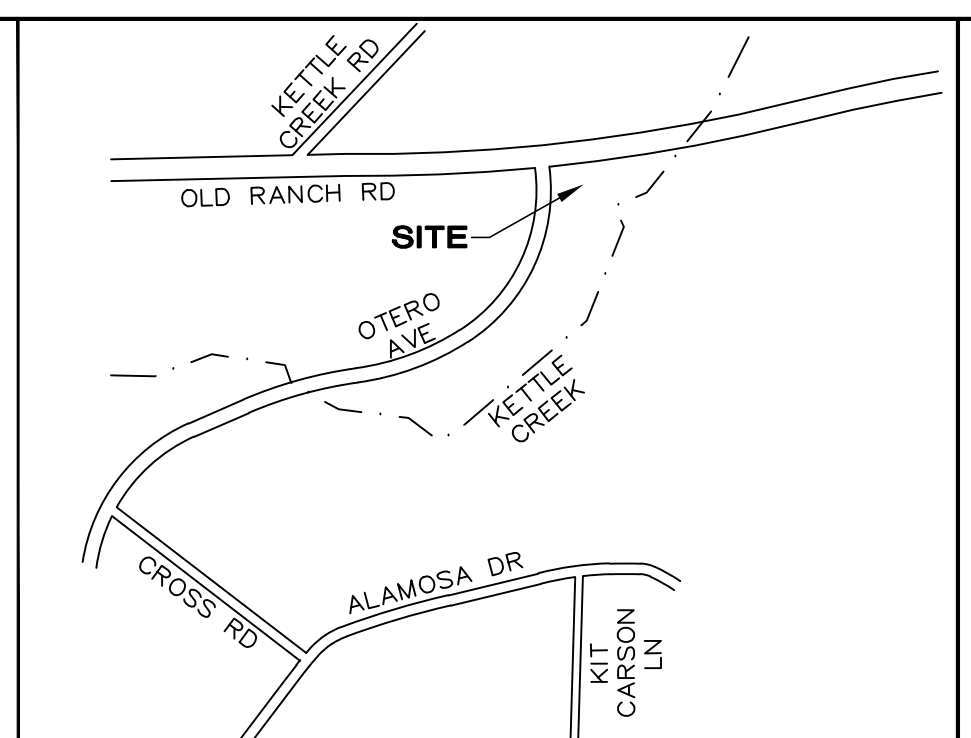
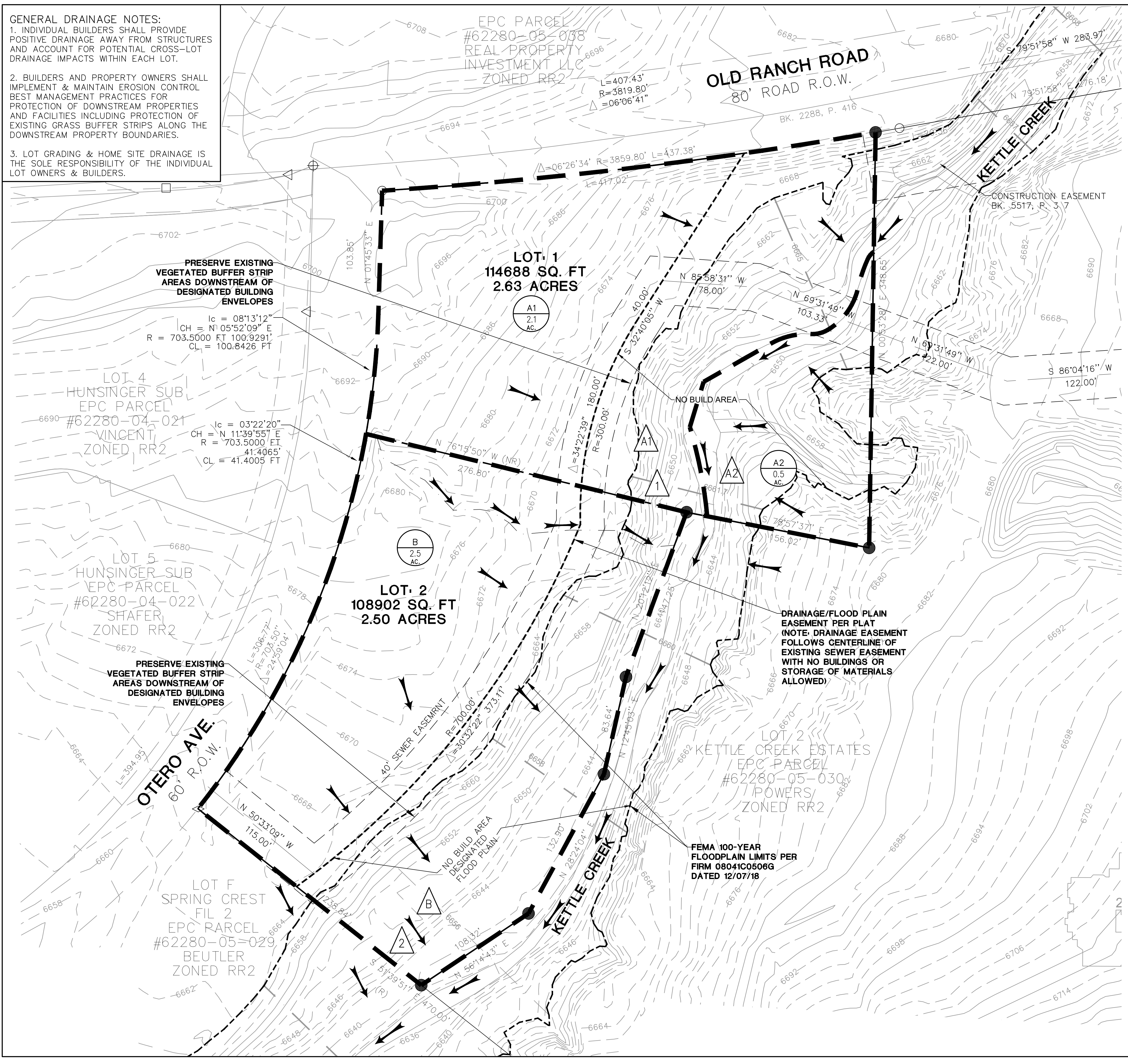
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.





**GENERAL DRAINAGE NOTES:**

- INDIVIDUAL BUILDERS SHALL PROVIDE POSITIVE DRAINAGE AWAY FROM STRUCTURES AND ACCOUNT FOR POTENTIAL CROSS-LOT DRAINAGE IMPACTS WITHIN EACH LOT.
- BUILDERS AND PROPERTY OWNERS SHALL IMPLEMENT & MAINTAIN EROSION CONTROL BEST MANAGEMENT PRACTICES FOR PROTECTION OF DOWNSTREAM PROPERTIES AND FACILITIES INCLUDING PROTECTION OF EXISTING GRASS BUFFER STRIPS ALONG THE DOWNSTREAM PROPERTY BOUNDARIES.
- LOT GRADING & HOME SITE DRAINAGE IS THE SOLE RESPONSIBILITY OF THE INDIVIDUAL LOT OWNERS & BUILDERS.



**LEGEND**

- LIMITS OF DISTURBANCE
- - - FEMA 100-YEAR FLOODWAY
- - - FEMA 500-YR FLOODPLAIN
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- PROPOSED CONTOUR
- EXISTING CONTOUR
- FLOWLINE
- FLOW DIRECTION ARROW
- △ DESIGN POINT
- BASIN DESIGNATION
- BASIN AREA (ACRES)

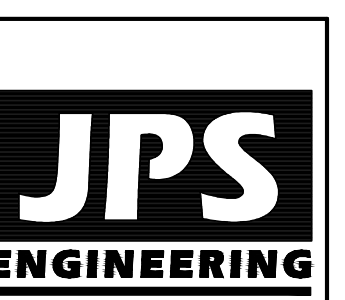
**BASIN SUMMARY TABLE**

BASIN	Q5 (CFS)	Q100 (CFS)
A1	1.7	6.8
A2	0.2	1.4
B	1.7	7.1

**SUMMARY HYDROLOGY TABLE**

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
1	1.9	8.0
2	3.4	14.4

**KETTLE CREEK ESTATE FILING NO. 2  
EL PASO COUNTY, CO**



19 E. Wilamette Ave.  
Colorado Springs, CO 80903  
PH: 719-477-9429  
FAX: 719-471-0766  
www.jpseng.com



CALL UTILITY NOTIFICATION CENTER OF COLORADO  
**1-800-922-1987**  
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

**DEVELOPED  
DRAINAGE PLAN**

HORZ. SCALE: 1"=40'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: CORNERSTONE	CHECKED: JPS
CREATED: 08/29/22	LAST MODIFIED: 16/08/24
PROJECT NO: 112303	MODIFIED BY: PV
SHEET:	<b>D1</b>